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AGRICULTURAL MEMORANDUM NO 868

A PRACTICAL APPROACH TO THE USE OF MEAN MAXIMUM AND MINIMUM TEMPERATURES FOR CALCULATING ONTARIO UNITS.

S N WASS

1. INTRODUCTION

Agricultural Memorandum number 848 demonstrates that Ontario Units calculated from Mean Maximum and Minimum temperatures can be subject to considerable errors. It is argued in Ag Mem 858 that this occurs because of the variability of the ~~minima~~ TEMPERATURES about their respective Means. Corrections are derived, in Ag Mem 858, based on the standard deviation of these temperatures.

2. ESTIMATING STANDARD DEVIATIONS

Standard deviations (SDs) of Maximum and Minimum temperatures are not usually available but estimates can be made from their ranges which are more readily available. For example they are given in the 'Agro-met Stations Summary', on Metform F3208 and can be deduced from the 'Monthly Weather Report'.

For independent variables

$\hat{\sigma} = An\,R$ where $\hat{\sigma}$ = Estimate of SD, An = Weighting factor for n variables, R = Range

Tables of An are given in most statistical publications. However temperatures are not independent variables and so the number of observations in a month has to be scaled by a persistence factor. SDs and ranges of both Maximum and Minimum temperatures were obtained for the 9 stations listed in Table 1, for the months May to October for 1973 and 1974. Plots of SD against range (Figs 1 and 2) both give a best fit straight line by eye with a gradient of 0.26. Although no correlation coefficients have been calculated the fit looks good enough to suggest that SDs may be estimated from

$$\hat{\sigma} = 0.26\,R$$

This represents a persistence factor of 1.7 days for Maximum and Minimum temperatures.

3. NIGHT AND DAY TERM CONTRIBUTIONS

Night and day term contributions have been calculated using the formulae derived in Ag Mem 858 and tabulated here for a range of Minimum and Maximum temperatures against standard deviation (Tables 3 and 4). Monthly Ontario Unit totals are given by

$(X + Y) \times N/2$ where X = Night term, Y = Day term, N = Number of days in month

FH2B

4. VALIDATION OF METHOD

Ontario Units were evaluated by the above method using SDs estimated from their ranges. The results shown in Table 2 are compared with those calculated using Mean Maxima and Minima only. Errors are taken to be the difference from the traditional method which sums the daily contributions. The improvement is statistically significant for May and highly significant for the remaining months. Using the corrected values all seasonal errors are less than 1% which is also highly significant.

Any comments or suggestions on this paper should be referred to the author.

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FIG 1 MINIMUM TEMPERATURE

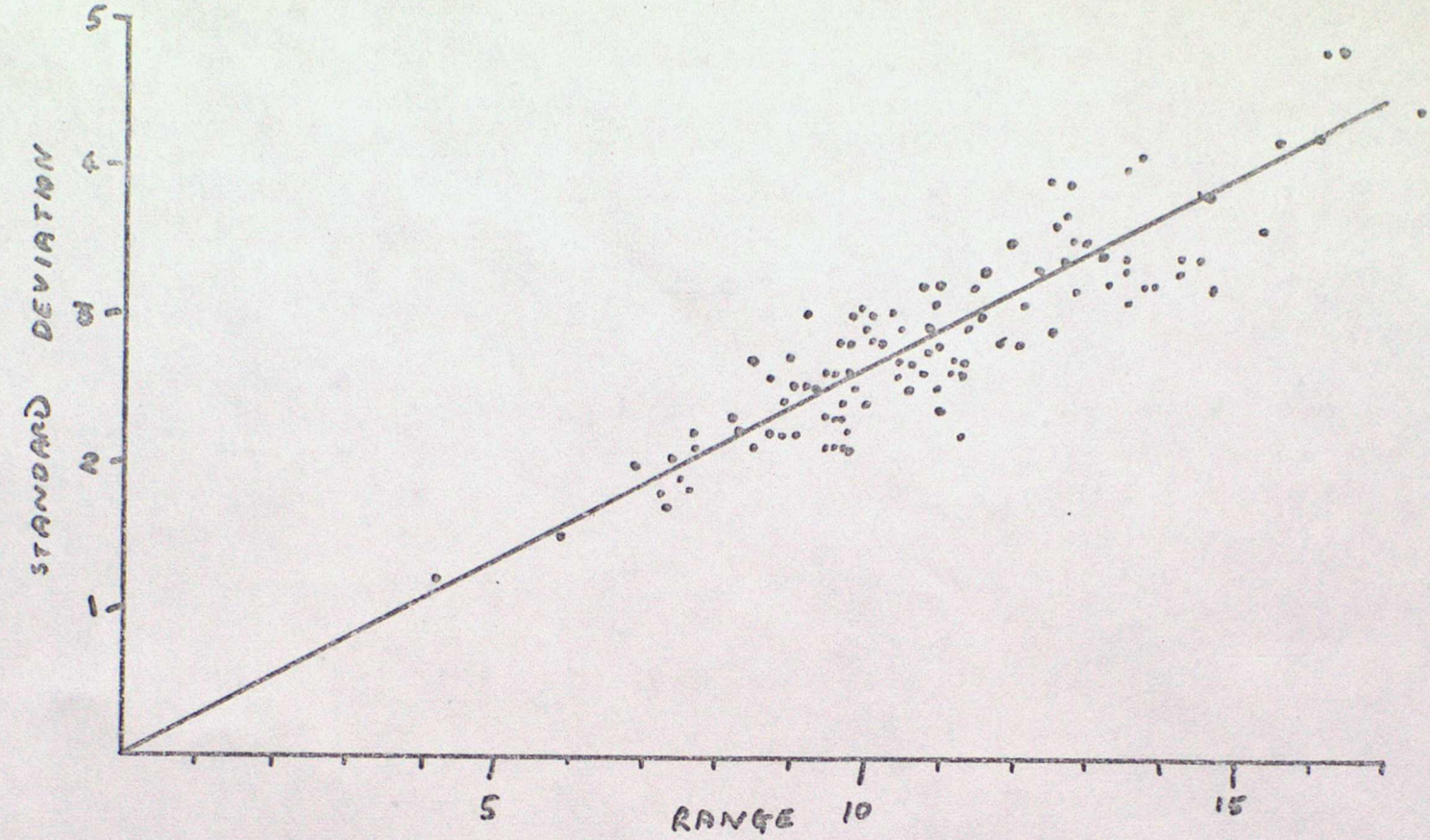

FIG 2 MAXIMUM TEMPERATURE

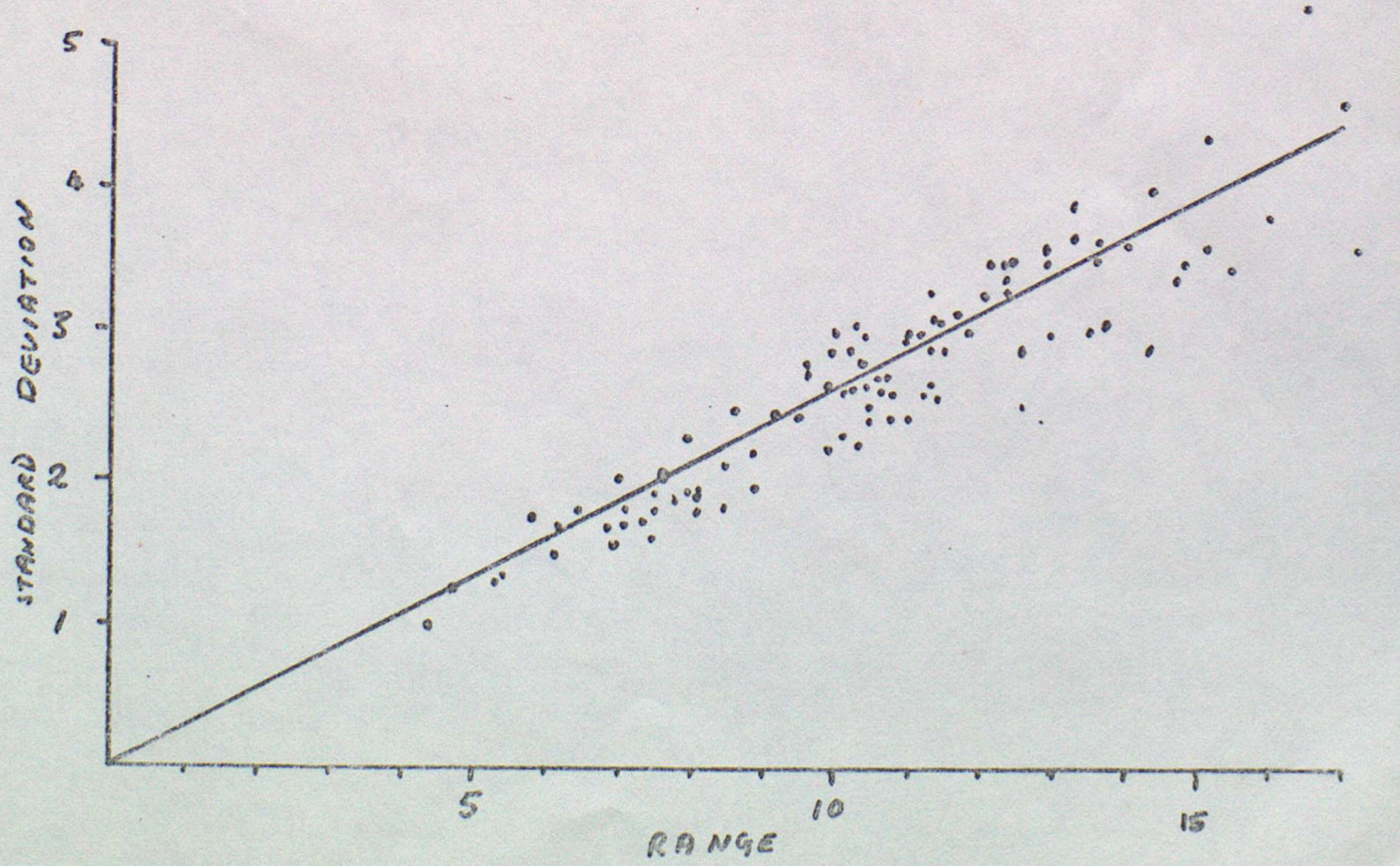

TABLE 1. STATIONS USED

Kinloss	East Malling	Southport
Leuchars	Boscombe Down	Valley
Preston Wynne	Abbotsinch	Long Ashton

TABLE 2.

Number of occasions in which the error is within given limit.

		ERROR LIMITS FOR TOTAL NUMBER OF UNITS					
		± 5	± 10	± 15	± 20	± 25	≷± 25
MAY	U	7	11	16	16	17	1
	C	13	17	18	18	18	0
JUNE	U	2	15	18	18	18	0
	C	17	18	18	18	18	0
JULY	U	9	17	18	18	18	0
	C	18	18	18	18	18	0
AUGUST	U	8	11	16	18	18	0
	C	17	18	18	18	18	0
SEPTEMBER	U	6	8	13	15	17	1
	C	14	18	18	18	18	0
OCTOBER	U	1	2	2	2	3	15
	C	13	15	18	18	18	0
SEASON	U	0	2	2	4	6	12
	C	6	13	17	18	18	0

U = Uncorrected monthly total - derived from mean Maxima and Minima
C = Corrected using the method outlined in Ag Mem 858

TABLE 3 X TERM

AVERAGE MINIMUM TEMPERATURE

SD	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0
0.25	0.0	0.0	0.0	0.0	0.0	1.1	2.9	4.7	6.5	8.3	10.1	11.9	13.7	15.5	17.3	19.1	20.9	22.7	24.5	26.3	28.1
0.50	0.0	0.0	0.0	0.0	0.1	1.1	2.9	4.7	6.5	8.3	10.1	11.9	13.7	15.5	17.3	19.1	20.9	22.7	24.5	26.3	28.1
0.75	0.0	0.0	0.0	0.0	0.3	1.2	2.9	4.7	6.5	8.3	10.1	11.9	13.7	15.5	17.3	19.1	20.9	22.7	24.5	26.3	28.1
1.00	0.0	0.0	0.0	0.1	0.4	1.4	2.9	4.7	6.5	8.3	10.1	11.9	13.7	15.5	17.3	19.1	20.9	22.7	24.5	26.3	28.1
1.25	0.0	0.0	0.0	0.1	0.6	1.5	3.0	4.7	6.5	8.3	10.1	11.9	13.7	15.5	17.3	19.1	20.9	22.7	24.5	26.3	28.1
1.50	0.0	0.0	0.1	0.3	0.8	1.7	3.1	4.7	6.5	8.3	10.1	11.9	13.7	15.5	17.3	19.1	20.9	22.7	24.5	26.3	28.1
1.75	0.0	0.0	0.1	0.4	0.9	1.9	3.2	4.8	6.5	8.3	10.1	11.9	13.7	15.5	17.3	19.1	20.9	22.7	24.5	26.3	28.1
2.00	0.0	0.1	0.2	0.5	1.1	2.0	3.3	4.8	6.5	8.3	10.1	11.9	13.7	15.5	17.3	19.1	20.9	22.7	24.5	26.3	28.1
2.25	0.0	0.1	0.3	0.7	1.3	2.2	3.4	4.9	6.6	8.3	10.1	11.9	13.7	15.5	17.3	19.1	20.9	22.7	24.5	26.3	28.1
2.50	0.1	0.2	0.4	0.8	1.5	2.4	3.6	5.0	6.6	8.3	10.1	11.9	13.7	15.5	17.3	19.1	20.9	22.7	24.5	26.3	28.1
2.75	0.1	0.3	0.5	1.0	1.6	2.6	3.7	5.1	6.7	8.4	10.1	11.9	13.7	15.5	17.3	19.1	20.9	22.7	24.5	26.3	28.1
3.00	0.2	0.3	0.6	1.1	1.8	2.7	3.9	5.3	6.8	8.4	10.1	11.9	13.7	15.5	17.3	19.1	20.9	22.7	24.5	26.3	28.1
3.25	0.2	0.4	0.8	1.3	2.0	2.9	4.1	5.4	6.9	8.5	10.2	11.9	13.7	15.5	17.3	19.1	20.9	22.7	24.5	26.3	28.1
3.50	0.3	0.6	0.9	1.5	2.2	3.1	4.2	5.5	7.0	8.6	10.2	12.0	13.7	15.5	17.3	19.1	20.9	22.7	24.5	26.3	28.1
3.75	0.4	0.7	1.1	1.6	2.3	3.3	4.4	5.7	7.1	8.6	10.3	12.0	13.7	15.5	17.3	19.1	20.9	22.7	24.5	26.3	28.1
4.00	0.5	0.8	1.2	1.8	2.5	3.4	4.5	5.8	7.2	8.7	10.3	12.0	13.8	15.5	17.3	19.1	20.9	22.7	24.5	26.3	28.1
4.25	0.6	0.9	1.4	2.0	2.7	3.6	4.7	5.9	7.3	8.8	10.4	12.1	13.8	15.5	17.3	19.1	20.9	22.7	24.5	26.3	28.1
4.50	0.7	1.1	1.5	2.1	2.9	3.8	4.9	6.1	7.5	8.9	10.5	12.1	13.8	15.6	17.3	19.1	20.9	22.7	24.5	26.3	28.1
4.75	0.8	1.2	1.7	2.3	3.1	4.0	5.0	6.2	7.6	9.0	10.6	12.2	13.9	15.6	17.3	19.1	20.9	22.7	24.5	26.3	28.1
5.00	0.9	1.3	1.8	2.5	3.2	4.2	5.2	6.4	7.7	9.2	10.7	12.3	13.9	15.6	17.4	19.1	20.9	22.7	24.5	26.3	28.1

TABLE 4 Y TERM

AVERAGE MAXIMUM TEMPERATURE

SD	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0
0.25	0.0	0.0	0.0	0.0	0.0	0.3	3.2	6.3	9.2	12.0	14.5	17.0	19.2	21.3	23.2	24.9	26.5	27.9	29.1	30.1	31.0
0.50	0.0	0.0	0.0	0.0	0.0	0.7	3.2	6.3	9.2	12.0	14.5	16.9	19.2	21.2	23.1	24.9	26.4	27.8	29.1	30.1	31.0
0.75	0.0	0.0	0.0	0.0	0.1	1.0	3.3	6.3	9.2	11.9	14.5	16.9	19.1	21.2	23.1	24.9	26.4	27.8	29.0	30.1	31.0
1.00	0.0	0.0	0.0	0.0	0.3	1.3	3.4	6.3	9.2	11.9	14.5	16.9	19.1	21.2	23.1	24.8	26.4	27.8	29.0	30.1	31.0
1.25	0.0	0.0	0.0	0.1	0.5	1.6	3.6	6.3	9.1	11.8	14.4	16.8	19.1	21.1	23.0	24.8	26.3	27.7	29.0	30.0	30.9
1.50	0.0	0.0	0.0	0.2	0.7	1.9	3.8	6.4	9.1	11.8	14.4	16.8	19.0	21.1	23.0	24.7	26.3	27.7	28.9	30.0	30.9
1.75	0.0	0.0	0.1	0.4	1.0	2.2	4.1	6.4	9.1	11.7	14.3	16.7	18.9	21.0	22.9	24.6	26.2	27.6	28.8	29.9	30.8
2.00	0.0	0.1	0.2	0.5	1.2	2.5	4.3	6.6	9.1	11.7	14.2	16.6	18.9	20.9	22.8	24.6	26.1	27.5	28.8	29.8	30.7
2.25	0.0	0.1	0.3	0.7	1.5	2.8	4.5	6.7	9.1	11.7	14.2	16.5	18.8	20.8	22.7	24.5	26.0	27.4	28.7	29.7	30.6
2.50	0.1	0.2	0.4	0.9	1.8	3.1	4.8	6.9	9.2	11.7	14.1	16.5	18.7	20.7	22.6	24.4	25.9	27.3	28.6	29.6	30.5
2.75	0.1	0.3	0.6	1.2	2.1	3.3	5.0	7.0	9.3	11.7	14.0	16.4	18.6	20.6	22.5	24.3	25.8	27.2	28.5	29.5	30.4
3.00	0.2	0.4	0.8	1.4	2.3	3.6	5.2	7.2	9.4	11.7	14.0	16.3	18.5	20.5	22.4	24.1	25.7	27.1	28.3	29.4	30.3
3.25	0.3	0.5	1.0	1.6	2.6	3.9	5.5	7.4	9.5	11.7	14.0	16.2	18.4	20.4	22.3	24.0	25.6	27.0	28.2	29.3	30.2
3.50	0.4	0.7	1.2	1.9	2.9	4.1	5.7	7.5	9.6	11.7	14.0	16.1	18.3	20.3	22.2	23.9	25.4	26.8	28.1	29.1	30.0
3.75	0.5	0.8	1.4	2.1	3.1	4.4	5.9	7.7	9.7	11.8	13.9	16.1	18.2	20.2	22.0	23.7	25.3	26.7	27.9	29.0	29.9
4.00	0.6	1.0	1.6	2.4	3.4	4.6	6.2	7.9	9.8	11.8	13.9	16.0	18.1	20.0	21.9	23.6	25.1	26.5	27.8	28.8	29.7
4.25	0.8	1.2	1.8	2.6	3.6	4.9	6.4	8.1	9.9	11.9	13.9	16.0	18.0	19.9	21.7	23.4	25.0	26.4	27.6	28.6	29.5
4.50	0.9	1.4	2.0	2.8	3.9	5.1	6.6	8.2	10.1	12.0	14.0	15.9	17.9	19.8	21.6	23.3	24.8	26.2	27.4	28.5	29.4
4.75	1.1	1.6	2.2	3.1	4.1	5.4	6.8	8.4	10.2	12.0	14.0	15.9	17.8	19.7	21.5	23.1	24.6	26.0	27.2	28.3	29.2
5.00	1.2	1.8	2.4	3.3	4.4	5.6	7.0	8.6	10.3	12.1	14.0	15.9	17.8	19.6	21.3	23.0	24.5	25.8	27.0	28.1	29.0